CONCENTRATION OF CERTAIN ORGANIC COMPOUNDS IN THE BLOOD OF THE AMERICAN COCKROACH, PERIPLANETA AMERICANA LINNAEUS[1]

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Most of the published material on the composition of insect blood deals with insects having a holometabolous life cycle. This work has been reviewed in texts on insect physiology by Chauvin (1949), Wigglesworth (1950) and Roeder (1953). In general they are in agreement that insect haemolymph is characterized by a high concentration of non-protein nitrogen, 50 to 80 per cent being amino nitrogen and a high concentration of reducing substances.

Since very little work has been done on the organic constituents of the blood of paurometabolous insects, this study was undertaken to determine the concentration of various nitrogenous fraction and reducing compounds in the blood of the American cockroach, *Periplaneta americana.*

MATERIAL AND METHODS

The cockroaches were kept at room temperature in glass jars containing laboratory food pellets and were supplied with water. To obtain uncoagulated blood, the insects were etherized, Ludwig (1951). The antennae were clipped with a pair of sharp scissors and the haemolymph was allowed to drip into a depression of a porcelain spot-plate. To facilitate bleeding, the abdomen was compressed during the process. The blood was measured with a micro pipette and 0.1 ml. was used for each test.

Protein and non-protein nitrogen were determined by the micro-Kjeldahl procedure. Amino acid nitrogen was measured by the method of Danielson as modified by Frame, Russell and Wilhelmi (1943). Reducing compounds were determined by the

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Hagedorn Jensen method as described by Hawk, Oser and Summerson (1951) and non-fermentable reducing compounds by a modification of the method of Somogyi (1927). These procedures were used as described by Ludwig (1951) for the study of insect blood. Uric acid nitrogen was determined by the method of Brown (1945).

OBSERVATIONS

The results of all the determinations are compiled in Table 1. Protein nitrogen was 740, and non-protein nitrogen, 259 mg.

TABLE 1

CONTENT OF CERTAIN ORGANIC COMPOUNDS IN THE HAEMOLYMPH OF THE AMERICAN COCKROACH. VALUES ARE GIVEN IN MILLIGRAMS PER CENT.

Substance	No. of Tests	Minimum value	Maximum value	Average values
Protein nitrogen	10	476	1,000	740
Non-protein nitrogen	10	154	322	259
Amino acid nitrogen	10	67.4	109	78
Reducing compounds	11	110	288	221
Non-fermentable reducing compound	10	88	280	192
Uric acid nitrogen	10	2.97	5.77	4.68

per cent. Total nitrogen, estimated by adding protein and non-protein nitrogen, was approximately 1,000 mg. per cent. Amino acid nitrogen was found to be 78 mg. per cent or about 35 per cent of the total non-protein nitrogen. Uric acid was 14.30, and uric acid nitrogen, 4.68 mg. per cent.

The average concentration of reducing compounds was 221, and of non-fermentable reducing compounds, 192 mg. per cent. Hence, that of fermentable reducing compounds (glucose) was only 30 mg. per cent.

In general these analyses on the haemolymph of the American cockroach agree with the results obtained by investigators on the blood of other insects as given by Buck (1953). The figures for

amino acid nitrogen in the blood of insects reported by Buck, averaged 224 mg. per cent. However, these readings were made on insects with holometabolous development. The American cockroach contained only 78 mg. per cent amino nitrogen. Leifert (1935) in her work on the blood of the larvae of the moth *Antheraea pernyi,* reported 80 mg. per cent, and Levenbook (1950) reported 94 mg. per cent amino nitrogen in the blood of larvae of the botfly, *Gastrophillus intestinalis.* The concentration of amino acid nitrogen obtained in the present work was estimated to be about 35 per cent of the total non-protein nitrogen. Wigglesworth (1950) and Buck (1953) estimated that the amino acid nitrogen is from 50 to 80 per cent of the non-protein nitrogen. However, these percentages were also based on readings obtained for holometabolous insects.

Yeager and Fay (1935) studied the reducing compounds in the American cockroach in connection with a study of the coagulation of the haemolymph. They fractionated the blood after treating the insects in different ways. One method was to collect the haemolymph under oil and allow it to stand 15 minutes and then remove the coagulum of cells. The mean total reducing substances found by them was 62, as compared with 221 mg. per cent found here. However, the present determinations involve the use of whole blood and consequently are not comparable to those of Yeager and Fay.

SUMMARY

A study was made on the concentration of nitrogenous and reducing compounds in the haemolymph of the American cockroach, *Periplaneta americana.*

Total nitrogen concentration was 1,000 mg. per cent, 740 of which was contained in the protein and 259, in the non-protein fraction. Amino nitrogen averaged 78 mg. per cent, or 35 per cent of the total non-protein fraction. The concentration of uric acid was 14.3 and of uric acid nitrogen 4.68 mg. per cent.

The total value of reducing compounds was 221 mg. per cent of which 192 mg. per cent were not fermentable. Hence, only about 30 mg. per cent were fermentable and may be considered glucose.

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University, who discussed flight controls in insects. Dr. Smyth discussed the body form of most insects, which renders them unstable for flight. A variety of mechanisms exist for controlling flight. In the early 1940's, Hollick showed that production of movements in the antennae of flies contributed to the maintenance of flight and regulated pitching movements of the insect's body, through changes in the angle of the wing stroke. Sensory hairs in the head, and at the base of the halteres of several flies have been shown to serve similar functions with regard to rolling movements of the insect in flight. Dr. Smyth indicated that, although generally without critical study, changes in metabolism during prolonged flight can modify the speed and angle of flight. Newer methods of studying insect flight include application of DDT to the sense organs regulating flight and observing the resultant changes in the insects behavior, and the technique of recording the nerve impulses from sense organs contributing to the regulation of steady flight.

After a discussion period, the meeting adjourned at 9:30 P.M.

EDWARD S. HODGSON, *Secretary*

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